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Field Control of Pavement Concrete[1]

By H. S. Mattimore
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THE MAIN factors controlling the service value of a concrete pavement are design and concrete quality. These factors are interdependable, as the design is based on the strength of concrete slab, therefore, providing due consideration is given to anticipated traffic loads and subgrade foundations, the efficiency of the road slab is governed by concrete quality.

Concrete Quality

The quality of the concrete in the finished surfacing depends upon the quality and quantity of cement, fine and coarse aggregate, methods used in proportioning, time of mix, quantity of water used, methods of placing, methods used in finishing, and methods and duration of curing and protection. A neglect in the supervision and inspection of any of these operations has at least an effect on the ultimate maintenance cost and service value of the road surface, and may, under certain conditions, be a direct cause of failure.

Materials

Most engineers now realize that the quality of materials used in their concrete has a considerable bearing on the efficiency of the finished structure. This has resulted in better material specifications, and, in most of the larger organizations, in the organization of a laboratory for the testing of materials. Usually we find that the specifications and methods of tests are well provided for, but the field control of the materials is still at its early stage of advancement. Efficient specifications, and the ascertaining of quality by preliminary testing, are essential provisions, but unless the organization is perfected so as to fully control the quality of materials being used, the specifications and testing lose a large part of their value. Many highway departments are realizing this and have organized and trained engineers to control this phase of inspection.

[1] Presented before the Fourteenth Annual Highway Conference, University of Michigan, February 14-17, 1928.

Material Inspection

The place at which materials are to be controlled depends mainly on geographic situation. Some highway departments have found it economical and satisfactory to establish inspection at the material plant. Where materials are segregated, this may be the proper procedure, but in some other sections where material sources are scattered and many small producers exist, this method is not only expensive, but likely to be inefficient if plant inspectors are not of a high type and closely supervised. Further, I do not believe that any organization responsible for the supervision of pavement construction can guarantee a final inspection of aggregate at the source. Even assuming that efficient inspection is maintained at the source, it is possible for aggregates to get segregated in sizes or to become contaminated with harmful materials during loading and handling.

Inspection at destination has been found to work efficiently in some states. In some of these locations I have found that the most successful method of control is what may be considered combination of inspection at the source and destination. Under this plan, where the amount of shipments warrant it, cement for which no method of field testing is feasible should be inspected at the source. This can be stored in assigned bins under seal, and shipments made under the supervision of the inspector. So far as concrete aggregates are concerned, inexpensive field equipment for the testing of grading, organic content, and silt are available. In order to have such a system work successfully, the following plan should be followed:

Preliminary inspection must be made of material sources prior to approving the product. Second, subsequent periodic inspections must be made at all aggregate plants; such periods to be regulated by the quality of the material received from the different plants. Third, provisions must be made to thoroughly train

the inspector who is responsible for the sampling and testing of the material at the destination.

This latter provision can be accomplished by holding brief courses on materials within the organization itself, or at some university, and to follow this up by having material inspectors travel from the materials division. The duty of these inspectors is to visit various contracts to instruct the contract plant inspector in sampling and field testing of materials, and make periodic inspections at material sources. These men should submit frequent reports to the materials division relative to the condition on the various contracts and material plants which they visit.

Proportioning

The proportions of cement and aggregates, and the detail methods used for gaging them, have a major effect in the efficiency and durability of a concrete road slab. During the past four or five years, several methods for the ideal proportioning or, as they are termed, "the design of concrete mixes," have been given considerable publicity. Some of these methods in practice have been reported to be economical, and at the same time resulting in a concrete of the desired strength. To date I do not know of any practical method for the utilization of these designs in concrete road work of any magnitude. Usually they require change in proportioning where the materials very in gradation; also, preliminary experiments have to be made on coarse and fine aggregates that are to be used on the work. This presents difficulties where the work is let by contract, from the standpoint that the general quality of material can be specified, but the actual source is not always known. Also, unless definite material data can be given, a contractor would have difficulty in preparing an estimate. Therefore, although the arbitrary mixes, as used, may not be ideal, they are more easily controlled and better fit the conditions in a large highway construction program.

As a result of investigations in the laboratory and field, many highway departments are giving consideration to the proportioning of aggregates by weight. This has many advantages over the customary volumetric proportioning, especially for the fine aggregate. Published data are available, demonstrating that more uniform strengths are obtained with this method of proportioning. After considerable investigation, the Committee on Character and Use of Road Materials of the Highway Research Board, in its report of 1926, recommends that concrete aggregates should be proportioned by weight. This is further emphasized in the 1927 report. The American Association of State Highway Officials has submitted a report from one of its committees, through letter ballot, to different states, recommending that the weight proportioning of concrete aggregates be adopted as a standard, and the probabilities are that many highway departments will adopt this method of proportioning as a standard within the next two years.

The time of mix, and the quantity of water used in the mix, have been so thoroughly discussed during the past several years that I believe most highway engineers are educated to the point where they fully realize that these are operations which should be carefully supervised. The tendency for increased production on the part of operators may at times cause an inclination to speed up the time of mix, and favor a wetter mix to facilitate handling.

Placing

Careless methods of placing concrete in pavement may lead to segregation, porosity, and thin slab depth. Lack of inspection at this stage of the operation may have a serious effect on the strength of the slab. In modern practice, where from 800 to 1,000 feet of concrete road slab has been laid in a day, an inspector has to be alert to assure himself that the proper depth of concrete is being laid throughout the section. Subgrade testers, if properly used, would detect a shortage of depth on the main part of the subgrade, but additional precautions must be observed to have any excess of material removed which has accumulated near the forms so that the full height of the form is exposed.

Finishing

Probably there have been more changes in methods of finishing of concrete pavement than any other operation. In this connection, the hand and mechanical screed are the usual specified preliminary steps, followed by belting, rolling and floating. It may not be possible to standardize these operations, as there are probabilities of certain methods of finishing being adaptable to certain concrete mixes, but, regardless of what methods are used in the finishing, precautions should be taken to avoid over-finishing. The demand for smooth-riding surfaces may lead to such over-finishing with its resulting evils, the most serious of which is a scalded surface. Probably one of the tools which is responsible for more over-finishing than any other, is the long-handled float. This is apparently a desirable occupation for the workman, and I have found in many cases that it is a difficult one to control.

Curing

There is probably no other concrete structure built under such severe conditions as the concrete road slab. We have data on file of the construction of the concrete highway in which the water was pumped from 5 to 6 miles, the materials were hauled 10 miles, and the temperature during part of the day was 100 degrees with low humidity. Test of the temperature of the water showed it to be close to 100 degrees. Under such conditions, a concrete road slab has very little opportunity to develop essential characteristics, unless special precautions are taken in prompt and efficient curing. On the project I refer to it was found necessary to thoroughly saturate the aggregates in the stockpile, and to apply a double thickness of saturated burlap at an early stage after finishing, in order to avoid hair checking.

Our investigations of the cause of hair checking has led us to definitely conclude that it is caused by a rapid dehydration of the concrete; therefore, the logical cure is to prevent this rapid dehydration by applying water at the proper time. I might say that the proper time and place to apply this water is not in the mixer, as excess water at that period not only causes a segregation in the mix, but probably aggravates rather than cures the condition. Do not treat this hair checking as a slight defect as by drilling into the road slabs, we have found these checks in some cases to extend through half the depth of a 7-inch slab. It is possible to correct this condition, and in cases where proper precautions are taken, it is practically eliminated.

General Inspection

Careless work, such as too wet a consistency and improper mixing, careless placing, over-finishing of the surface, improper placing of expansion joints, poor alignment of the center line joint, and non-uniformity in subgrade depth, are conditions which have been great factors in causing highway surfaces to be unsatisfactory where conditions have showed the design and material used were excellent for the purpose. These apparent minor details of inspection may be the major factors in the ultimate results obtained. Many comparative examples can be cited in different sections where highway surfacing built under almost identical specifications and of the same design, in one case is practically a failure, and in another an excellent example of durable construction. This difference in results can be almost entirely attributed to the quality and kind of inspection. Some defects that may occur in a concrete road slab which can be eliminated or at least remedied by efficient inspection are:

Surface scale, many cases of which have been traced to late finishing, over-finishing, or an excess of fines in the sand.

Porosity, due either to concrete of too wet a consistency or improper placing. Excessively dry concrete may be porous, if not properly placed, but the usual fault is to have concrete too wet rather than too dry.

Spalling at expansion joints due to improper alignment or improper placing of joints. Care to secure proper alignment and rigidity by proper staking will eliminate this trouble.

Spalling or shearing at edge of pavement at expansion joint. This occurs where the expansion joint material does not extend clear through to the edge of the pavement, and the remedy is to inspect this condition and where necessary cut the joint through at the edge.

Weak, unreliable, inefficient inspectors are a factor in producing poor results, while efficient work on the part of the inspector can be observed in many excellent samples of concrete highways in various parts of the United States. Another factor that cannot be too forcibly presented to the inspector is that the majority of good specifications written at the present day are the result of past experience and practice. The idea in writing these specifications is to give an accurate guide to the contractor and inspector, and in cases where specifications are practicable, intelligent ones, they must be followed practically to the letter. In cases where impracticable, indefinite specifications exist, the only remedy is to rewrite them before the contract is let and the work proceeded with. In other words, it is my opinion that no inspector should have the privilege to change specification requirements on major items. If such a condition exists, we can establish as many standards as we have inspectors employed.

Tests on Finished Concrete

An equally important provision for field control of pavement concrete is the sampling and testing of the finished product. If properly controlled, the results of these tests should give considerable information relative to the aggregates used, proportioning, efficiency of mix, etc. Until the past few years, the practice has been to depend entirely upon compression tests on cylinders made and usually stored in the field and tested in the laboratory. The new thickened-edge road slab, the design of which is based on modulus of rupture, computed from the transverse tests, has revived interest in this latter test to an extent where it

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Patching Streets in West Palm Beach[1]

By O. F. Reynaud

SYSTEMATIC maintenance is the best road investment the community can make, for makeshift methods of patching reveal themselves in a very short time. The unique method of patching used at West Palm Beach, Fla., has presented a very economical program. This method is used for patching various types of bituminous surfaces and cement-concrete pavements.

At the mixing plant is a one-sack concrete mixer, a storage tank for asphaltic oil, and necessary equipment for heating the asphalt. Small stone and sand are piled near the mixer.

Materials and Mixing

The materials are clean stone in size from ½-inch down, with dust removed, any clean sand (ordinary bank sand has been found satisfactory) and Texaco macadam binder, a heavy asphaltic oil containing a minimum of 86 per cent asphalt of 100 penetration, which was used because of its quick-drying quality.

In the concrete mixer stone and asphalt are first mixed. The stone is dumped in, a few shovelfuls at a time, and then the asphaltic oil, heated to about 250 degrees F., is poured in. The mixing of these two continues until all the stone is thoroughly coated with the hot oil. For the one-sack mixer the following proportions were found best to use: 30 shovels of rock, 17 shovels of sand, and 5 or 6 gallons of asphaltic oil. The quantity of oil must be governed by the porosity of the rock and the nature of the sand, but around 8 per cent of asphaltic oil is sufficient. Slow continued mixing assures better and more uniform coating. By first mixing the rock and asphaltic oil, "clotting" or "balling" is eliminated after the sand is introduced. Sand is then dumped into the mixer, two or three shovels at a time, and when the desired amount is in, and the ingredients have been mixed for at least five minutes, the mix is dumped into a wheelbarrow and then into a pile. A little fire is kept immediately under the mixing drum to prevent sudden chilling of the asphaltic oil. This also tends to give a more uniform mixture.

Storage of Finished Mixture

Although it would be better to store the mixture under a shed, it has been found that disinetgration will not take place when it is exposed to showers, nor become hard and packed, requiring picking to remove, if left in the open for a period of a week or so. If the weather is quite cool, the mix may tend to pack somewhat, but under normal weather conditions the asphalt will remain intact and not "run." The sand should govern that feature.

Preparation of Street for Patching

The hole is cleaned out with a broom before the mixture is dumped in, but it is not necessary to paint the inside of the hole first. In case the hole is shallow, it is advisable to paint it lightly. For larger and deeper holes, one or more inches deep, the sides of the hole should be vertical to offer resistance to the mixture when rolled.

Laying and Care of the Patch

The mixture is dumped into the hole and rolled, rather than tamped. For a patch 1 inch deep, 1½ inches of material is spread and then rolled to grade. Tamping may be excessive and crush the surface rock. A 3-ton roller is satisfactory. Following the rolling, the surface of the patch appears to be a binder course of sheet asphalt pavement. Sand covering is used, or the surface may be sealed with a flush coat of the asphaltic oil and sanded. After this the patch is opened immediately to traffic.

It will be found that, if properly rolled, the patch remains firm in place and intact from the time rolling has ceased. It may be evident that a little of the asphalt will tend to "bleed." This is desirable, and a little sand thrown over the spot will take up the excess asphalt and seal the patch. Other than to watch the patch for bleeding, there is no attention required.

Labor and Costs

At the mixing plant one man attends to the mixing. He knows the proper proportions and attends to this feature. One man handles the shovels and wheelbarrow and one the heating of the asphalt and dumping. Three men can easily mix and place in storage 14 to 15 cubic yards in a day. The number of men on the street crew depends on the extent of work to be done. If a large patch is to be laid, extending the width of the street and for an appreciable distance, four men can do the work—one truck driver, one roller operator, and two spreaders. For a job of this size, labor is cut to a minimum if an air-compressor drill is used

[1] From *The American City*, Vol. XXXVIII, No. 6, June, 1928.

to prepare the street. This may be mounted on the truck carrying the mix.

West Palm Beach cost figures are as follows:

Actual cost of mixing:	
Labor (three men)	$10.30 per day
Sand	1.00 per cubic yard
Stone	3.00 per cubic yard
Asphaltic oil, approx.	.10 per gallon
(Above prices f. o. b. mixing plant.)	

Figuring capacity of 14 cu. yds. per day as a basis:

10 cubic yards rock	$30.00
4 cubic yards sand	4.00
18 gallons asphalt per cubic yard mixture	25.20
Labor	10.30
Total	$69.50

Approximately $5.00 per cubic yard for the finished mixture.

The labor cost for the laying operation is governed by the size and amount of work to be done. The maximum figure of cost was 10 cents per square yard, while the average cost is 3 cents to 5 cents.

One and one-half cu. ft. of the patching mixture will cover 1 sq. yd., 2 inches thick. At a cost of $5 per cu. yd. for the mixture, this would mean an expenditure of 28 cents per sq. yd. for patching material, to which must be added 3 cents to 5 cents per sq. yd. for laying.

Comments and Observations

Local conditions will vary the type of stone and sand available, but several grades of stone have been tried at West Palm Beach, also different sands, all with about equal success. The mixture cools uniformly after mixing, and is ready for use immediately or later, as desired.

There are several stretches of the patching material in West Palm Beach that extend the entire width of the street, and for a distance of at least 25 feet. On one of these streets, following the rolling and sanding, 50 trucks, each weighing 4½ tons, rolled over the patch, and there was not the slightest depression. The patch after rolling becomes dense and very firm, and will not push or shove under traffic. It may be that smaller rock will require somewhat less sand when mixing, but the proper proportions are best ascertained by experience.

It is needless to say that the maintenance problem of streets has been one of the most important that confront engineers. Certain materials used for patching streets are very expensive. The method at West Palm Beach has caused a number of cities on the East Coast of Florida to become interested, and some have adopted it with equal success.

A. S. Hobby, City Engineer of West Palm Beach, and D. D. Howard, Street Superintendent, devised this method of patching and are responsible for the systematic and economical program of work.

Field Control of Pavement Concrete

(*Continued from page 3*)

is rapidly replacing the compression tests for the control of pavement concrete.

The logical assumption that the stress applied to the test specimens should have a definite relation to the stresses used as a basis for design of the structure, justifies adoption of the transverse tests. Further, this test has been found to be especially applicable to field control, as it can be made at the site of the work by inexpensive equipment, thereby eliminating expenses and delays of shipping to the laboratory. These advantages, taken into account with published data showing more concordant results. on the transverse than the compression tests, are responsible for the favor with which this test is being received.

All organizations supervising concrete pavement construction should make tests on specimens molded from concrete placed in the road slab. In order that the results of such tests shall be indicative of the strength of the concrete in the road surface, great precautions should be taken to have the men who make the specimens and perform the tests, thoroughly trained. In our organization, inspectors from the Materials Division are responsible for training the engineers and inspectors from the construction division along this line. The concrete for the test specimens is taken after the material is dumped and placed on the road surface. Several other methods were tried, such as dumping directly into a container, etc., but the method of sampling from the material in place gave more uniform results. The specimens are cured in the same manner as the pavement.

Practically all our field tests are performed at destination by construction engineers and inspectors. The aggregate testing is handled by plant inspectors assigned to the central proportioning plant at the material delivery site. The transverse concrete test is also carried on here, but is under the supervision of an assistant engineer of construction. This method of control has worked satisfactorily in our organization. If any one point should be selected as of the utmost importance in this method of control, it would be the thorough training of the inspector responsible for the sampling and field testing and detailed supervision by traveling inspectors from the Materials Division.

Our experience has been that the inspection of aggregates at destination has led the producer to realize his responsibility in the quality of material shipped. Many of these producers have assigned their own inspectors to the sampling and testing of materials prior to shipment.

Mines and Quarries Establish Notable Safety Records

ESPECIALLY noteworthy instances of the long-continued operation of large mines and quarries without injuries to employees are revealed in the announcement of the leading participants in the National Safety Competition held during the calendar year 1927 under the auspices of the United States Bureau of Mines, Department of Commerce. A large Michigan iron mine, two non-metallic mineral mines located in Illinois and Ohio and 27 quarries and open-pit mines located in Texas, Kansas, Pennsylvania, California, Alabama, Indiana, New York, Minnesota, Kentucky, Maryland, Ohio and Michigan were operated throughout the year without a single accident involving loss of working time on the part of an employee. Two hundred and fifty-six mines and quarries, representing 31 states, were represented in the contest. The total amount of exposure to hazard was 91,919,812 man-hours. In addressing congratulatory letters to the winning mines or quarries in each group of contestants, Secretary Hoover of the Department of Commerce declared that the achievement represented a definite contribution to the personal welfare of industrial workers and marked a forward step in the elimination of unnecessary accidents in American industry. Commendatory letters were written by Director Scott Turner, of the Bureau of Mines, to the various mines and quarries awarded honorable mention in the contest.

Third Year of Competition

The holding of the National Safety Competition in 1927 marked the third consecutive year of this notable endeavor to reduce, through the medium of friendly competition, the number of personal injuries in the mines and quarries of the United States. Competing companies were grouped into five classes, namely, anthracite mines, bituminous coal mines, metal mines, non-metallic mineral mines, and quarries and open-pit mines. To the winning company in each group was awarded the bronze trophy Sentinels of Safety, the gift of The Explosives Engineer magazine. The winner in each group was the mine or quarry whose record showed the smallest loss of time from accidents in proportion to the total amount of time worked by all employees.

The competition for the trophy was restricted to mines employing at least 50 men underground and to quarries and open-pit mines employing at least 25 men in the pit.

Anthracite Mining Group

First place in the anthracite mining group was awarded to the Jeddo-Highland Coal Company's Highland No. 6 mine, at Jeddo, Luzerne County, Pennsylvania. This mine worked 134,680 man-hours in 1927 and had a loss of only 0.119 days per thousand man-hours of exposure.

Honorable mention in the anthracite mining group of contestants was given to the Upper Lehigh mine, of the Hazlebrook Coal Company, Upper Lehigh, Pennsylvania; the Jeddo No. 7 mine, of the Jeddo-Highland Coal Company, Jeddo, Pennsylvania; the Ebervale mine of the Jeddo-Highland Coal Company, Jeddo Pennsylvania; and the Lawrence mine, of the Harleigh-Brookwood Coal Company, Mahanoy Plane, Pennsylvania.

Bituminous Mining Group

No. 2 mine of the United States Coal and Coke Company, at Gary, West Virginia, was the leader of the bituminous coal mine group. This mine's record showed 688,937 man-hours worked in 1927 with an accident-severity rate of 0.132 and an accident-frequency rate of 1.5, while the average rates for the whole bituminous group were 15.739 for severity and 97.3 for frequency.

Honorable mention, in the bituminous group, was given the No. 4 mine of the United States Coal and Coke Company, at Thorpe, West Virginia; the Panther mine of the United States Fuel Company, Heiner, Utah; the No. 9 mine of the United States Coal and Coke Company, Filbert, West Virginia, and the No. 8 coal mine of the United States Coal and Coke Company, Elbert, West Virginia.

Metal Mine Group

Bristol iron-ore mine at Crystal Falls, Iron County, Michigan, operated by the Bristol Mining Company, won first place in the metal-mine group. The Bristol mine was operated in 1927 without a lost-time acci-

dent, although the mine employed about 140 men and worked 434,916 man-hours.

In the metal mine group, honorable mention was given the Lucky Bill lead and zinc mine, of the Federal Mining and Smelting Company, Cardin, Oklahoma; the Berkshire iron-ore mine of the Brule Mining Company, Stambaugh, Michigan; the Armour No. 2 iron-ore mine of the Inland Steel Company, Crosby, Minnesota, and the Lucky Jew zinc and lead mine, of the Eagle-Picher Lead Company, Treece, Kansas.

Non-metallic Minerals Group

The best record among mines producing non-metallic minerals other than coal was established by the Marquette Cement Manufacturing Company at the company's limestone mine at La Salle, La Salle County, Illinois. This mine was operated without a lost-time accident in 1927. During the year the employees worked 205,601 man-hours.

Honorable mention, in the non-metallic mineral mine group, was given the Ironton cement rock mine of the Alpha Portland Cement Company, Ironton, Ohio; the Missouri Portland Cement Company limestone mine, Cement City, Missouri; the Manheim cement rock mine of the Alpha Portland Cement Company, Manheim, West Virginia; and the Southard gypsum mine of the United States Gypsum Company, Southard, Oklahoma.

Quarries and Open-pit Mines

The leading plant among quarries and open-pit mines was the Mitchell limestone quarry, at Mitchell, Lawrence County, Indiana, operated by the Lehigh Portland Cement Company. The Mitchell quarry and crusher were operated without a lost-time accident in 1927; its volume of exposure was 308,886 man-hours.

In the quarry and open-pit mine group, honorable mention was given the following contestants:

Ormrod limestone quarry, of the Lehigh Portland Cement Company, Ormrod, Pennsylvania.

Union Bridge limestone quarry, of the Lehigh Portland Cement Company, Union Bridge, Maryland.

Security cement rock quarry, of the North American Cement Corporation, Security, Maryland.

Union Limestone Company quarry, Hillsville, Pennsylvania.

Bath limestone quarry, of the Lehigh Portland Cement Company, Bath, Pennsylvania.

White Haven sandstone quarry, of the General Crushed Stone Company, Whitehaven, Pennsylvania.

Louisville Cement Company cement rock quarry, Speed, Indiana.

Texas Portland Cement Company limestone and shale quarry, Dallas, Texas.

Kansas Portland Cement Company limestone and shale quarry, Bonner Springs, Kansas.

Ash Grove Lime and Portland Cement Company limestone quarry, Chanute, Kansas.

Pennsylvania-Dixie Cement Corporation Plant No. 6 cement rock and limestone quarry, Nazareth, Pennsylvania.

Iola limestone quarry, of the Lehigh Portland Cement Company, Iola, Kansas.

Cowell Portland Cement Company lime rock quarry, Cowell, California.

Alabama Portland Cement Company limestone quarry, Birmingham, Alabama.

Lehigh Lime Company (Mitchell) limestone quarry, Mitchell, Indiana.

Helderberg limestone quarry of the North American Cement Corporation, Howes Cave, New York.

York open-pit iron-ore mine, of the York Iron Mining Company, Nashwauk, Minnesota.

Sandts Eddy limestone quarry of the Lehigh Portland Cement Company, Sandts Eddy, Pennsylvania.

Sandusky Cement Company limestone quarry (silica), Toledo, Ohio.

Wickwire Spencer Steel Company limestone quarry, Gasport, New York.

Pennsylvania-Dixie Cement Corporation Plant No. 4 cement rock quarry, Nazareth, Pennsylvania.

Olive Hill Limestone Company crushed limestone quarry, Olive Hill, Kentucky.

Martins Creek No. 3 cement rock quarry, of the Alpha Portland Cement Company, Martins Creek, Pennsylvania.

Alabama Portland Cement Company shale quarry, Birmingham, Alabama.

Bellevue cement rock quarry, of the Alpha Portland Cement Company, Bellevue, Michigan.

Consolidated Cement Corporation limestone quarry, Mildred, Kansas.

The records of the National Safety Competition of 1927 again demonstrated the fact that most mining and quarrying companies are succeeding in their efforts to prevent accidents to their employees, the Bureau of Mines points out. This is indicated by the records which showed that a majority of the companies had accident-severity rates lower, and therefore better, than the average rates for their respective groups.

May Had Largest Construction Record

The highest month ever recorded for construction started in the 37 States east of the Rocky Mountains is the report of the F. W. Dodge Corporation. New building and engineering work contracted for in these States (about 91 per cent of the total country) during the past month amounted to $668,097,200. This tops the previous high record of April, 1928, by about 25 million dollars. The increase over May of last year was 21 per cent.

The combined total for new construction started during the first five months of this year is also a record breaking figure. The total for the first five months of 1926 held the record up until now. This year's figure, amounting to $2,796,301,300 is 9 per cent ahead of the total for the first five months of last year and is 7 per cent over the total for the corresponding period of 1926.

The Crushed Stone Journal

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Send in Your Cost Questionnaire

IT WILL be remembered that Mr. J. R. Thoenen of the U. S. Bureau of Mines in Washington appeared before our West Baden Convention and offered the services of the Bureau of Mines in conducting an investigation into the costs involved in the production of crushed stone. He proposed that if the industry desired information along this line and would extend their cooperation, the Bureau of Mines would collect the necessary information through a questionnaire and correlate the data.

The Convention unanimously voted that the Association should cooperate with the Bureau of Mines in a cost investigation of the industry, and upon his return to Washington, Mr. Thoenen prepared and distributed a questionnaire designed to provide the Bureau with the necessary data.

Our latest advice from Mr. Thoenen is that the number of questionnaires returned to date is gratifying but that a very appreciable proportion of the industry has not as yet been heard from.

It would hardly seem necessary to point out the many advantages to be derived by our industry in having a governmental bureau perform this very valuable work which if done by ourselves would prove prohibitive in cost.

At our annual meeting we gave assurance to Mr. Thoenen that we would cooperate with the Bureau of Mines in conducting this investigation by promptly filling out and returning the cost questionnaires. The returns to date would indicate that we are not fulfilling our pledge made at West Baden. We are all more or less victims of the put-it-off habit and undoubtedly therein lies the difficulty in the present situation.

We earnestly request that all of those who have not yet done so, please forward immediately to Mr. J. R. Thoenen, Bureau of Mines, Washington, D. C., the cost questionnaire recently distributed by him throughout the industry.

On the strength of our vote to cooperate, the Bureau of Mines has set up the necessary machinery to tabulate and correlate statistical information of intense value and interest to our industry and it will be most unfortunate if a representative response is not obtained. Additional copies of the questionnaire may be had upon request to either Mr. Thoenen or to the Association headquarters in Washington.

Progress of the Testing Laboratory

CONSIDERABLE progress has been made in the equipping of our new testing laboratory in the Merchandise Building at 14th and S Sts., Washington, D. C., and in the installation of the electrical and plumbing fixtures necessary for its operation.

Unusually complete screening apparatus has been set up for the preparation of the large samples to be used in our concrete investigations and for the making of mechanical analyses with either circular or square opening screens. This apparatus includes a 3′ x 5′ vibratory screen with a large assortment of screen plates, a special rocking screen in which circular opening plates are used, also a Ro-Tap laboratory sieving machine and a complete set of Tyler sieves.

We are provided with a small laboratory grinder for preparing samples of stone-sand which we propose to investigate in a very thorough manner. A small laboratory crusher will also be available within a short time.

Complete stone testing equipment, such as the Deval abrasion machine, the Dorry hardness machine, the Page impact machine, a diamond saw, grinding lap and diamond core drill are also being placed in position. We are laying a great deal of emphasis on the installation of devices which will make for uniformity in testing. For illustration, our moist rooms for curing of concrete and mortar will be temperature controlled, and mine sprayers are installed to insure 100 per cent humidity at all times. The temperature of the storage water in our storage tanks is controlled by means of a regulating valve which automatically

regulates the temperature of the storage water to 70° F. at all times, irrespective of fluctuations in the temperature of our water supply. In the summer weather, the temperature of the tap water in Washington rises to above 70° F., so that precautions are necessary to provide a means for cooling the water to the right temperature before it enters the storage tanks.

Our 300,000-pound testing machine is now almost completed. It is of the Southwark-Emery type and special precautions are being taken by the manufacturers to produce for us an unusually fine piece of testing equipment. We have found it necessary to design and construct a number of pieces of auxiliary apparatus to accompany this machine, including special bearing blocks for transverse testing and special pulling heads for the testing of concrete in tension. Every precaution has been taken to eliminate the possibility of error in our test results through the installation of apparatus which is theoretically correct.

Large samples of materials for investigation have already been received and more are on their way to the laboratory at the present time. In addition to installing apparatus, we have begun our first series of investigations consisting of extensive tests involving the effect of gradation on voids. This series should be valuable in showing stone producers how to best grade their stone to produce the highest yield of concrete. It will be our aim to publish our results as rapidly as they become available after review by our Research Committee.

A very cordial invitation to visit our laboratory is extended to everyone interested.

Southwestern Division Holds Annual Meeting

THE Annual Meeting of the Southwestern Division of the National Crushed Stone Association was held at New Braunfels, Texas, on April 30, 1928.

The morning was devoted to an inspection of the three crushed stone plants located at New Braunfels, namely the Landa Rock Products Company, the Dittlinger Lime Company and the New Braunfels Limestone Company, after which a splendid chicken dinner was served at the cafe in Landa's Park overlooking the beautiful Comal River.

The afternoon was devoted to a business session which was held in the offices of the Dittlinger Lime Company. After disposing of the regular order of business, the election of officers for the ensuing year took place, resulting in the re-election of all of the officers as follows:

W. F. Wise, Texas Trap Rock Corporation, President.

E. Eikel, Dittlinger Lime Company, Vice-President.

C. Westbrook, Landa Rock Products Company, Treasurer.

R. J. Hank, Secretary-Manager.

Research Committee Meets in Washington

THE Research Committee of the Association held its first meeting of the year at the Cosmos Club, Washington, D. C., on May 25, 1928, with the following in attendance:

John W. Stull, Chairman, Liberty Lime & Stone Co., Rocky Point, Va.
L. C. Bonnell, F. R. Upton, Inc., Newark, N. J.
C. E. Glassen, Columbia Quarry Co., Columbia, Ill.
A. T. Goldbeck, Nat'l Crushed Stone Ass'n, Washington, D. C.
R. G. L. Harstone, Canada Crushed Stone Corp., Hamilton, Canada.
H. F. Kriege, France Stone Co., Toledo, Ohio.
C. A. Munson, New Haven Trap Rock Co., New Haven, Conn.
A. B. Rodes, Franklin Limestone Co., Nashville, Tenn.
W. R. Sanborn, Lehigh Stone Co., Kankakee, Ill.
G. E. Schaefer, General Crushed Stone Co., Rochester, N. Y.
J. E. Gray, National Crushed Stone Assn., Washington, D. C.
J. R. Boyd, National Crushed Stone Assn., Washington, D. C.

Previous to the meeting, an inspection was made of the Association's research testing laboratory and new headquarters, located in the Merchandise Building at Fourteenth and S Streets, N. W., and from the enthusiastic comment expressed by various members of the Committee, it was evident that they were exceedingly well pleased with the laboratory lay-out and new headquarters.

Following the inspection, the meeting convened at the Cosmos Club with John W. Stull, Chairman of the Committee, presiding.

In his opening remarks, Mr. Stull explained that the meeting had been called for the purpose of enabling the Committee to discuss with Mr. Goldbeck the various investigations which should be undertaken in the research testing laboratory. He also stated that the research laboratory offered the Association an unusual opportunity for engaging in constructive work for the benefit of the entire industry.

Mr. Goldbeck, Director of the Bureau of Engineering, was then asked to discuss the proposed outline of investigations, copies of which had previously been provided to all present.

In opening the discussion, Mr. Goldbeck pointed out that the problems of most importance to the industry should be undertaken first and that the advice of the Committee was desired in order to properly determine which investigations should be given precedence.

A general discussion followed, during which many interesting and valuable suggestions were contributed, evidencing a keen appreciation, on the part of the members of the Committee, of the responsibilities placed upon them.

After a thorough discussion had taken place, a motion was unanimously carried approving the outline of investigations as submitted by Mr. Goldbeck, and authorizing him to proceed with the various projects in their relative order of importance as determined by him.

It was suggested that it would probably be desirable to hold another meeting of the Committee in the Fall, after which the meeting adjourned subject to the call of Chairman Stull.

Iowa Producers Discuss Problems

AT A MEETING held in Dubuque on Monday, June 4, Iowa producers of crushed stone met with officers of the National Association to discuss problems of interest to the industry in that section.

It developed that the most serious problem seemed to lie in the fact that encouragement was being given by the State to the operation of small road-side crushing plants poorly equipped and operated by those of little or no responsibility, in preference to the established commercial producer having thousands of dollars invested.

This condition seemed to be due chiefly to the fact that the highway commission feels that good concrete can be made without regard to grading of the aggregate providing sufficient cement is used. It was felt that the thing to do was to convince the highway department that roads could be constructed more economically by using less cement and a better, though more expensive, grading of aggregate.

Mr. Goldbeck, Director of the Bureau of Engineering, offered the assistance of the Association's research laboratory for any work which might prove of benefit in convincing the commission of the economy of using a good, clean, well graded aggregate.

Mr. Boyd, Secretary of the National Association, spoke briefly regarding Association activities and urged the cooperation of those present in obtaining new members for the Association.

At the luncheon held between the morning and afternoon sessions of the meeting, there were a number of guests present, including A. O. Kratz, City Manager of Dubuque, and W. H. Cullen, City Engineer.

Pennsylvania Producers Reorganize

A REORGANIZATION meeting of the crushed stone producers of Pennsylvania was held at the Penn-Harris Hotel, Harrisburg, on May 28, 1928.

Previous to this time there had been in existence two organizations of crushed stone producers in the State known as the Western Pennsylvania Stone Producers Association and the Eastern Pennsylvania Association, each functioning as an entirely independent group. Believing that one organization embracing the entire State could better serve the interests of the industry in Pennsylvania, particularly in view of the fact that a problem of utmost seriousness which hitherto had chiefly concerned the interests of western producers threatened to extend to other sections of the State, it was deemed highly desirable to merge the two existing organizations into one association to be known as the Pennsylvania Stone Producers Association. Preliminary steps in that direction were taken at the meeting held in Harrisburg on May 28, which was attended by producers from various sections of the State.

Mr. William M. Andrews, president of the Western Pennsylvania Stone Producers Association, acted as chairman of the meeting and in his opening remarks directed attention to the many problems confronting the industry in Pennsylvania which could be more effectively solved through the united efforts of all producers working through one organization than through two organizations, or through the efforts of individual producers.

Mr. H. B. Allen, General Crushed Stone Company, Philadelphia, speaking on behalf of the producers from the eastern part of the State, heartily subscribed to the idea of one organization and felt that there would be little difficulty in interesting most of the tonnage in his section in joining the new association.

Mr. Goldbeck, Director of the Bureau of Engineering of the National Association, stated that excellent progress was being made in the establishment of the research testing laboratory, most of the equipment having been purchased and installed. He also briefly

outlined the investigations which are to be carried on in the laboratory and felt that the data to be obtained from the first main project should yield facts which would prove of decided value in effecting a solution of some of the more acute problems confronting the Pennsylvania producers.

Mr. Boyd, Secretary of the National Association, briefly discussed the many ways in which local organizations working in cooperation with the National Association can be a real force for the betterment of conditions affecting the interests of producers.

After a general discussion on the subject of reorganization, contributed to by producers representing all sections of the State, it seemed to be the unanimous opinion of the meeting that one organization should be formed and a motion was therefore passed to this effect.

For the purpose of interesting more of the Pennsylvania producers in the new organization, another meeting was held in Harrisburg on June 21 with a large number of new companies represented who were not able to attend the previous meeting.

A committee composed of F. O. Earnshaw, M. L. Jacobs, F. T. Gucker, H. B. Allen, A. L. Sheffer, A. V. Vannerman and G. I. Purnell was appointed for the purpose of drafting a suitable constitution and by-laws to be presented to the association at its next regular meeting for ratification.

It was decided to hold this next meeting at the Penn-Harris Hotel, Harrisburg, on Thursday, July 19, at 11:00 a. m., standard time, and a most cordial invitation to attend is hereby extended to all crushed stone producers of Pennsylvania.

Mid-West Division Meets in Chicago

The Mid-West Division of the Association met at the Great Northern Hotel, Chicago, on June 5.

Col. O. P. Chamberlain, president of the Division, was prevented from attending by illness and in the absence of W. R. Sanborn, regional vice-president of the National Association, Howard E. Bair, a member of the Executive Committee of the National Association, consented to preside.

The primary purpose of the meeting was to discuss the work of the newly established research testing laboratory and to give the national officers an opportunity to ask the Division for increased financial assistance for the laboratory.

Due to illness, President Graves was prevented from attending the meeting and in his absence Mr. Goldbeck and Mr. Boyd discussed respectively the work contemplated in the laboratory and the need of additional support from the Mid-Western producers.

The meeting passed a resolution authorizing the President to appoint a committee for the purpose of personally visiting and interesting all members of the Division in contributing to the laboratory fund.

The remainder of the meeting was devoted to a discussion of the agricultural limestone situation.

Associate Members of the National Crushed Stone Association

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Crushing Plants and Machinery.

American Manganese Steel Co., Chicago Heights, Ill.
"Amsco" Manganese Steel Castings.

American Tar Products Co., Union Trust Bldg., Pittsburgh, Pa.
Tar Products for Road Construction and Maintenance.

Armstrong Manufacturing Co., Waterloo, Iowa.
Blast Hole Drills, Bit Dressing Machines.

Atlas Powder Co., Wilmington, Del.
Explosives and Blasting Accessories.

Earle C. Bacon, Inc., 26 Cortlandt St., New York City.
Complete Plants, Crushers, Elevators, Screens, Conveyors.

Bakstad Crusher & Equipment Corp., 122 So. Michigan Ave., Chicago, Ill.
Bakstad Patented 3-Jaw Crusher.

The Barrett Company, 40 Rector St., New York City.
Tarvia for Road Construction, Repair and Maintenance.

R. H. Beaumont Co., 319 Arch St., Philadelphia, Pa.
Crushers, Feeders, Elevators, Conveyors and Bunkers.

Blaw-Knox Co., P. O. Box 915, Pittsburgh, Pa.
Manufacturers of Steel Products.

The Browning Crane Co., 16226 Waterloo Rd. N. E., Cleveland, Ohio
Locomotive Cranes.

C. G. Buchanan Co., Inc., 90 West St., New York City.
Crushers, Crushing Rolls, Magnetic Separators.

Bucyrus-Erie Company, South Milwaukee, Wis.
Shovels—Steam, Diesel, Electric and Gasoline—and Dredges.

Buffalo Wire Works, 521 Terrace, Buffalo, N. Y.
Wire Cloth and Screens.

Burrell Eng. & Constr. Co., 513 West Jackson Blvd., Chicago, Ill.
Design and Construction.

Canadian Explosives, Limited, Canada Cement Bldg., Montreal, Canada.
Explosives and Blasting Supplies.

The Carroll Chain Co., 265 Hosack St., Columbus, Ohio.
"Carroll" Solid Weld Steam Shovel Hoisting Chains.

Cement, Mill and Quarry, 101 31st St., New York City.

Cement, Mill and Quarry, 542 Monadnock Block, Chicago, Ill.
"Publishers."

Cross Engineering Works, Carbondale, Pa.
Perforated Metals.

Davis and Averill, 28 Fulton St., Newark, N. J.
Storage Bins.

The Dorr Company, 247 Park Ave., New York City.
The Dorr Washer.

E. I. Du Pont de Nemours & Co., Wilmington, Del.
"Explosives of All Kinds and Blasting Accessories."

Easton Car and Construction Co., Easton, Pa.
Quarry Cars.

Ensign-Bickford Co., Simsbury, Conn.
Safety Fuse and Cordeau Bickford Detonating Fuse.

Fate-Root-Heath Co., Plymouth, Ohio.
"Plymouth" Gasoline Locomotives.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago, Ill.
Alligator and Flexco H. D. Belt Fasteners.

Frog, Switch & Mfg. Co., Carlisle, Pa.
Manganese Steel Castings.

General Electric Co., Schenectady, N. Y.
Electrical Apparatus and Supplies.

Gill Rock Drill Co., Lebanon, Pa.
Blast Hole Drilling and Fishing Tools.

Good Roads Machinery Co., Kennett Square, Pa.
Crushers, Elevators, Elevator Feeders and Revolving Screens.

The Goodyear Tire and Rubber Co., Inc., Akron, Ohio.
Belting: Transmission, Conveyor, Elevator; Hose, Packing.

Graham Coal Company, Commercial Trust Bldg., Philadelphia, Pa.
Coal and Coke.

Grasselli Powder Co., Cleveland, Ohio.
Manufacturers of Explosives.

Gruendler Patent Crusher & Pulverizer Co., First and Franklin, St. Louis, Missouri.
Crushing, Pulverizing, Screening and Conveying Machinery.

Harnishchfeger Corporation, 38th & National Aves., Milwaukee, Wis.
Gasoline, Electric and Diesel Shovels—Cranes, Draglines.

The Hayward Co., 50 Church St., New York City.
Hayward Orange Peel and Clam Shell Buckets.

The Hendrick Mfg. Co., Carbondale, Pa.
Perforated Metal Screens, Elevator Buckets.

Heisler Locomotive Works, Erie, Pennsylvania.
Geared Locomotives.

Hercules Powder Co., Wilmington, Del.
Explosives and Blasting Supplies.

C. W. Hunt Co., 1580 Richmond Terrace, West New Brighton, N. Y.
Mitchell Electric Vibrating Screen.

Illinois Powder Manufacturing Co., St. Louis, Mo.
Explosives and Blasting Supplies.

Ingersoll-Rand Company, 11 Broadway, New York City.
Rock Drills, Steel Sharpeners, Oil Furnaces and Hoists.

The Jeffrey Mfg. Co., Columbus, Ohio.
Elevating and Conveying Machinery.

Kennedy-Van Saun Mfg. & Engr. Corp., 50 Church St., New York City.
Kennedy Gyratory Crushers.

Keystone Lubricating Co., Philadelphia, Pa.
Lubricating Greases and Lubricating Devices.

Keystone Division, McGraw-Hill Catalog & Directory Co., Inc., 475 10th Ave., at 36th St., New York City.
Publishers of Metal Quarry Catalog and Metal Quarry Directory.

Koehring Company, Milwaukee, Wis.
Gasoline Shovels, Cranes and Draglines.

Koppel Industrial Car and Equipment Co., Koppel, Pa.
Quarry Cars in hand and air operated designs—Track Material.

The Loomis Machine Co., Tiffin, Ohio.
Blast Hole, Prospecting and Drilling Machinery and Tools.

Manganese Steel Forge Co., Richmond St. and Erie Ave., Philadelphia, Pa.
"Rol-Man" Screens, Chains, Plates and Forged Products.

The Marion Steam Shovel Co., Marion, Ohio.
Power Shovels and Cranes—Steam, Gasoline and Electric.

Mid-West Locomotive Works, Cor. Spring Rd. and Alabama Ave., Cincinnati, Ohio.
Quarry Locomotives.

National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland, Ohio.
Naco Cast Steel Steam Shovel Chain and Certified Malleable Castings.

Niagara Concrete Mixer Co., 40 Pearl Street, Buffalo, N. Y.
"The Niagara Screen."

The Orville Simpson Co., 1230 Knowlton St., Cincinnati, Ohio.
Screens, ROTEX, level, self-cleaning, 100 to ¾" mesh.

The Osgood Company, Marion, Ohio.
Power Shovels and Combinations.

Peerless Explosives Co., 22 N. Franklin St., Wilkes-Barre, Pa.
Explosives and Blasting Supplies.

Pit and Quarry, Rand McNally Bldg., Chicago, Ill.
"Publishers."

Rinek Cordage Co., Easton, Pa.
"Rinek" Reliable Rope.

Rock Products, 542 So. Dearborn St., Chicago, Ill.
"Publishers."

Robins Conveying Belt Co., 15 Park Row, New York City.
Material Handling and Screening Equipment.

The Sanderson-Cyclone Drill Co., Orrville, Ohio.
Drills, Big Blast Hole, Drilling and Fishing Tools.

Sauerman Bros., Inc., 438 S. Clinton St., Chicago, Ill.
Cableway Excavators, Power Scrapers.

Smith Engineering Works, 32nd and Locust Sts., Milwaukee, Wis.
Rock Crushers—Gyratory, jaw and reduction.

The Stearns Conveyor Co., 200th St. & St. Clair Ave., Cleveland, Ohio.
Material Handling Machinery.

Stephens-Adams Manufacturing Co., Aurora, Ill.
Speed Reducers and Belt Conveyor Carriers.

Symons Bros. Co., 111 W. Washington St., Chicago, Ill.
Ore, Rock and Gravel Crushers.

S. G. Taylor Chain Co., 140 So. Dearborn St., Chicago, Ill.
Taylor Mesaba Steam Shovel Chains.

Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
TISCO Manganese Steel Castings.

The Thew Shovel Co., Lorain, Ohio.
Steam, Gasoline and Electric Shovels, Cranes, Draglines.

The Traylor Engineering & Mfg. Co., Allentown, Pa.
Crushing, Cement and Mining Machinery.

Traylor Vibrator Co., 1400 Delgany St., Denver, Colorado.
Vibrating "Screen Supreme."

Trojan Powder Co., Allentown, Pa.
Explosives and Blasting Supplies.

Troco Lubricating Co., Philadelphia, Pa.
Manufacturers of Petroleum Products.

The W. S. Tyler Co., Cleveland, Ohio.
Woven Wire Screens and Screening Equipment

Union Explosives Co., Clarksburg, W. Va.
Explosives and Blasting Supplies.

Vulcan Iron Works, Wilkes-Barre, Pa.
Steam, Gasoline, Electric Locomotives.

Western Wheeled Scraper Co., Aurora, Ill.
Western Portable Rock Crushers.

George D. Whitcomb Co., Rochelle, Ill.
Gasoline Locomotives.

Williams Patent Crusher and Pulverizer Co., 813 Montgomery St., St. Louis, Mo.
Hammer Crushers.